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QUARTERLY UPDATE MARCH 31, 1978

TECHNOLOGY APPLICATION CENTER
THE UNIVERSITY OF NEW MEXICO
ALBUQUERQUE, NEW MEXICO 87131

HEAT PIPE TECHNOLOGY

A BIBLIOGRAPHY WITH ABSTRACTS

QUARTERLY UPDATE

JANUARY-MARCH 1978

ASSEMBLED BY

THE HEAT PIPE INFORMATION OFFICE

OF

THE TECHNOLOGY APPLICATION CENTER
INSTITUTE FOR APPLIED RESEARCH SERVICES
THE UNIVERSITY OF NEW MEXICO
ALBUQUERQUE, NEW MEXICO 87131

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INTRODUCTION

This is the first quarterly update, for 1978, in Heat Pipe Technology.

The major portion of this quarter's activity has been in the areas of heat pipe applications in aerospace and nuclear systems. The categories of general theory and heat transfer have also experienced an increase in activity.

We would appreciate any comments or suggestions that you may have to contribute as we endeavor to make this a more complete and reader responsive publication.

Gilbert A. Rivera
Technical Editor

GUIDE TO USE OF THIS PUBLICATION

A number of features have been incorporated to help the reader use this document. They consist of:

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**Citation numbers appear on upper right corner of each page

I. GENERAL INFORMATION, REVIEWS, SURVEYS

HP78 10000 INTERNATIONAL HEAT PIPE CONFERENCE, SECOND, VOLUMES 1 AND 2, 1976

Anon., (CNR, Rome, Italy), Int Heat Pipe Conf, 2nd, Bologna, Italy, Mar 31-Apr 2, 1976, Publ by Eur Space Agency (ESA SP112), Noordwijk, Netherlands, V 2:877, 1976

This conference contains 74 papers dealing with all aspects of heat pipes, from scientific fundamentals to commercial applications. The topics of the eleven technical sessions are: gravity-assisted heat pipes; low-temperature heat pipes; liquid metal heat pipes; heat pipe dynamics; variable-conductance heat pipes; rotating heat pipes; heat pipe materials; evaporative heat transfer; terrestrial applications; zero-gravity testing; and spacecraft applications. This conference appears as two volumes; most of the technical papers are included in Volume One, and Volume Two contains post-deadline papers, a list of participants and an author index. Individual papers are indexed separately.

(HEAT TRANSFER, TEMPERATURE CONTROL, SPACECRAFT, OVERVIEW)

HP78 10001 HEAT PIPES IN EUROPE, THEIR DEVELOPMENT AND APPLICATION, A SURVEY

Brost, O., Muenzel, W.D., (Stuttgart Univ, TH, Germany, F.R.), Maschinemarkt, V 82: 513-517, N30, 1976, In German

The application of heat pipes has become of increasing interest due to their extraordinary properties (high heat transfer properties with small temperature gradients, spatial decoupling of heat sinks and heat sources and heat flow density transformation almost without temperature drops) and the possibility of using heat pipes for temperature control. There are many examples for the development and use of heat pipes in Europe.

(HEAT TRANSFER, HEATING, REVIEW)

HP78 10002 HEAT RECOVERY IN AIR SYSTEMS

(Heat and Vent Eng.), V 50:10, 12-14, N594, 4 refs, Jan 1977
Avail:TAC

No abstract available

(HEAT-PIPE, HEAT EXCHANGERS, OVERVIEW)

HP78 10003 HEAT PIPES

Jerman, R., Obz. Mat. Fiz., V 24:10-15, N1, Jan 1977, In Slovene

The basic aspects of heat pipes are considered. These are conductors of heat with very low and variable thermal resistance. Some applications are also mentioned.

(HEAT TRANSFER, OPERATION, OVERVIEW)

HP78 50004 HEAT PIPES: A NEW TYPE OF HEAT TRANSFER ELEMENT

Richter, W., (Technische Univ., Dresden, Germany, Sektion Energieumwandlung), Sanka to Fujinka, V 41:632-635, N10, 1976, In German

A short description of the functioning of heat pipes is given. The author's own studies on the use of network and artery heat pipes for heating, ventilation and air-conditioning are presented.

(NETWORK ARTERY HEAT-PIPES, HEATING, VENTILATION, AIR-CONDITIONING)

HP78 10005 GOVERNMENT FUNDING FOR HEAT PIPE RESEARCH PROMISES BENEFIT FOR DIECASTERS

Die Cast. and Met. Moulding (GB), V 8:7-8, N1, 2 refs, Jan - Feb 1977
Avail:TAC

No abstract available

(EVAPORATOR DEVELOPMENT, SERVICE LIFE)

II. HEAT PIPE APPLICATIONS

II. A. GENERAL APPLICATIONS

HP78 20000 CESIUM HEAT-PIPE NEUTRAL PARTICLE SPECTROMETER

Brisson, D.A., (North Carolina State Univ., Dept of Nuclear Engineering, Raleigh, NC), 1977, TID-27705

A new method of examining the energy spectra of neutral particles escaping a magnetically confined plasma was examined experimentally. Electron capture collisions in a cesium charge exchange heat pipe were used to attain conversion efficiencies more than two orders of magnitude greater than previously used stripping analyzers for neutral energies below 200 EV. Efficiency curves for the cesium heat pipe were obtained experimentally for hydrogen and deuterium using a coulutron ion beam system. The maximum hydrogen conversion efficiency was 3.9×10^{-2} at 500 EV, and the maximum deuterium conversion efficiency was 4.2×10^{-2} at 100 EV. The hydrogen and deuterium efficiencies at 100 EV were 1.1×10^{-2} and 4.2×10^{-3}, respectively. Cesium loss rates were measured with a surface ionization gauge. Neutral hydrogen energy measurements were made on the Elmo Bumpy Toras, which is a toroidal mirror machine located at Oak Ridge National Laboratory. These neutral energy spectra were unfolded to obtain ion temperatures for several plasma conditions. The ion temperatures obtained with the cesium heat pipe energy analyzer corresponded well to previous temperature measurements made with an N_2 stripping analyzer.

(ENERGY SPECTRA, ELECTRON CAPTURE, CONFINED PLASMA)

HP78 20001 HEAT PIPE: APPLICATIONS

Jog, V., Mujumdar, A.S., (McGill Univ., Montreal, Canada), J. Inst. Eng. (India), Chem. Eng. Div., V 57:83-88, N2, Feb 1977
Avail:TAC

The heat pipe consists essentially of a tube, a wick and a fluid that can transfer heat at a phenomenal rate. Because of its several unique characteristics, the heat pipe finds applications in diverse fields, ranging from solar energy utilization to cryosurgery. The applications and limits of the heat pipe are described and two specific topics are discussed in some detail, viz, applications pertaining to solar energy utilization and uses of coaxial heat pipes. A partial list is provided by the various fields in which the heat pipe can be used effectively.

(COAXIAL HEAT-PIPES, ENERGY CONVERSION, HEAT TRANSFER)

II. B. ENERGY CONVERSION AND POWER SYSTEMS

HP78 21000 METHANATION: WITH HIGH THERMODYNAMIC EFFICIENCY ENERGY RECOVERY

Biery, J.C., (Los Alamos Scientific Lab, NM), 28 refs, Jan 1977

Heat pipes could be utilized in the process of methanating synthesis gas from coal in two important ways. The first is in the methanator itself where the heat pipes are used for catalyst cooling, temperature control, and high-temperature isothermal energy recovery. The second involves recovering thermal energy in the exit gas stream from the methanator and using it to preheat the methanator inlet stream and also to produce steam from condensed water from the exit stream. The methanator has the following unique characteristics. It is composed of a dense assembly of heat pipes with stacks of cylindrical pellets of a catalyst such as $NiAl_2O_3$ intimately dispersed among them. Nickel concentration in the catalyst stacks is varied from 10 to 50 percent to limit the front end temperature within the methanator. Heat is extracted from the methanation reaction isothermally at temperatures approaching the upper operating limits of the catalyst - approximately 750 to 300°K. Energy is transported by the heat pipe into a steam boiler where superheated steam is produced. The post methanation recuperator is a unique three-chamber recuperator heat exchanger. Energy is transported between the inlet and outlet gas streams from the methanator in the lower chambers interconnected with heat pipes. In the upper chamber condensed water from the exit gas stream is transferred either to the inlet stream or to steam from the condensed water. Costs of the methanator and the recuperator appear to be somewhat lower than comparable units designed by El Paso Natural Gas Co., for their methanation plant at the Four Corners area. The extraction of the heat isothermally at high temperature and the efficient recuperation of the energy between the inlet and outlet gas streams make the present unit attractive.

(METHANATION, COAL GASSIFICATION, CATALYST COOLING)

HP78 21001 DEMAND SENSITIVE ENERGY STORAGE IN MOLTEN SALTS

Nemeck, J.J., Simmons, D.E., Chubb, T.A., (Naval Research Lab., Washington, DC), American Section of the International Solar Energy Society, Cape Canaveral, FL, Sharing the Sun: Solar Technology in the Seventies, V 8, 1976, Boeer, K.W., ed.

Heat-of-fusion energy storage and on-demand steam are obtained using heat pipe techniques to transfer heat to and from stacked salt cans and onto boiler tubes within a sealed "energy storage-boiler" tank for solar thermal power plants.

(HEAT-OF-FUSION, ENERGY STORAGE, ENERGY STORAGE-BOILER, SALTS)

HP78 21002 CHEMICAL METHODS OF STORING THERMAL ENERGY

Offenhartz, P.O., (EIC Corp., Newton, MA), American Section of the International Solar Energy Society, Cape Canaveral, FL, Boeer, K.W., ed., Sharing the Sun: Solar Technology in the Seventies, V 8, 1976

Thermal energy storage through chemical reactions is reviewed including second-law restrictions and opportunities. Second-law opportunities arise when the collection temperature exceeds the utilization temperature - in this case a thermochemically driven heat pump can be used to deliver considerably more heat than is collected. Chemical reactions can be chosen to fit the source and sink temperatures so as to amplify the input heat. A number of currently proposed methods (H_2 - generation and storage, hydration-dehydration equilibria, chemical heat pipes, and ammoniacal salt pairs) are assessed with respect to efficiency, cost, chemical feasibility, and suitability for various collection and utilization temperatures.

(CHEMICAL HEAT-PIPE, CHEMICAL FEASIBILITY, TEMPERATURE SUITABILITY)

HP78 21003 SOLAR RESIDENTIAL ELECTRIFICATION WITH HIGH PERFORMANCE HEAT ENGINES

Salter, R.M., (American Institute of Aeronautics and Astronautics, NY), 1975
Avail:TAC

Application of high-performance closed-cycle heat engines to solar energy conversion for residences and other buildings is considered. Stirling and recuperated Brayton cycles are investigated with the former favored due to commonality in construction with conventional small Otto cycle engines. Typical top temperatures of these cycles are near best compromise between thermodynamic efficiency vs. solar collection efficiency. The overall system includes an array of sun-following paraboloidal collectors connected by sodium heat pipes. Both heat and electrical buffering, control problems, accoutrements (such as heat pumps), other heat sources, and other electrical sources are examined. Analogous conversion of furnace fuel energy into electricity is considered.

(BRAYTON CYCLE, STIRLING ENGINE, PARABOLIC REFLECTORS)

HP78 21004 HEAT-PIPE BISMUTH LASER; EXAMINATION OF LASER ACTION AT 4722 ANGSTROMS IN BISMUTH VAPOR

Walter, W.T., Solimene, N., (Dep. Electr. Eng. Electrophys., Polytechnic Inst., Brooklyn, NY), Gov. Rep. Announce. Index (U.S.), V 77:233, N15, 1977
Avail:TAC

No abstract available

(BISMUTH HEAT-PIPE, LASERS)

HP78 21005 VAPIPE - A PRACTICAL SYSTEM FOR PRODUCING HOMOGENEOUS GASOLINE-AIR MIXTURES

Harrow, G.A., Mills, W.D., Thomas, A., Finlay, I.C., (Shell Res Ltd, Chester, England), SAE Prepr, 16 p., N760564 for Meet, June 7-10, 1976

The Vapipe is a device that has been developed jointly by Shell Research Limited, Thornton Research Centre, and the National Engineering Laboratory to reduce car exhaust emissions and improve fuel economy. It achieves better mixing of the charge entering the engine by vaporizing the gasoline in the inlet system. Heat for this purpose is conveyed from the exhaust system by means of a heat pipe. Two Vapipe systems have been tested, one in which surplus heat from the exhaust is rejected to the cooling system of the car and the second in which the boiler efficiency is varied to maintain the correct flow of heat to the fuel vaporizer. Both systems operate well but the latter is very much cheaper to make than the former. The Vapipe provides good mixture distribution and allows the engine to run smoothly at weak mixtures, thus permitting improvements in fuel economy and reductions in exhaust emissions. Substantial benefits have been obtained in practical installations, but these could be even greater if were developed in which the individual stringer survival probabilities were varied and the radiator system mass was calculated. Results are presented for system mass as a function of individual stringer survival probability for six candidate container materials, three candidate heat pipe fluids, two radiator operating temperatures, two meteoroid shield types, and two radiating surface cases. Results are also presented for radiator reject heat as a function of system mass, area, and length for three system sizes.

(THERMOELECTRIC, NUCLEAR-SPACE POWER, CONCEPTUAL DESIGN)

HP78 21006 CONCEPTUAL DESIGN OF A HEAT PIPE RADIATOR

Bennett, G.A., (Los Alamos Scientific Lab., NM), Sept 1977, LA--6939-MS

A conceptual design of a waste heat radiator has been developed for a thermoelectric space nuclear power system. The basic shape of the heat pipe radiator was a frustum of a right circular cone. The design included stringer heat pipes to carry reject heat from the thermoelectric modules to the radiator skin that was composed of small-diameter, thin-walled cross heat pipes. The stringer heat pipes were armored to resist puncture by a meteoroid. The cross heat pipes were designed to provide the necessary unpunctured radiating area at the mission end with a minimum initial system mass. Several design cases carburetters or other fuel-metering devices were developed to take maximum advantage of the homogeneous mixtures. Significant improvements in engine warm-up time, driveability, and flexibility of opera;tion are also achieved but power output is somewhat reduced.

(AUTOMOBILE ENGINES, FUEL ECONOMY, HEAT-PIPE FUEL VAPORIZER)

II. C. ENERGY CONSERVATION, SOLAR, NUCLEAR, AND OTHER ENERGY SYSTEMS

HP78 22000 A HEAT PUMP FOR THE INDUSTRY

Bachmann, D., (VDI, Frankfurt, Germany), Ind Anz, V 99:44-47, N3, 3 refs, Jan 12, 1977, In German

The article describes the design and operation of a newly developed heat pipe system - the so-called templifier - for the production of hot water (82°C) by utilizing excess heat from any available source of heat (32°C) which otherwise would be wasted.

(WASTE-HEAT UTILIZATION, TEMPLIFIER)

HP78 22001 HEAT PIPES FOR HOSTILE ENVIRONMENTS IN ENERGY CONSERVATION APPLICATIONS

Basiulis, A., Ewell, G.I., (Hughes Aircraft Co., Torrance, CA), In Intersociety Energy Conversion Engineering Conference, 12th, Washington, DC, Aug 28 - Sept 2, 1977, Proceedings, American Nuclear Society, Inc., La Grange Park, IL, V 1:493-497, 1977, (A77-48701 23-44), A77-48758

Heat Pipes offer many advantages for potential use in energy recovery applications unrestricted form factor, large choice of materials and material combinations, and each heat pipe can operate independently or in concert with other heat pipes in the heat recovery unit. A program was initiated to develop heat pipes for hostile environments such as sulfur plants and coal gasifiers. Heat pipe materials and potential coatings were evaluated for corrosive and abrasive environments from 200°C to 600°C. This study indicated that heat pipes can be designed and built for heat recovery, but compatibility data in the environment was lacking, and that field test data is badly needed. A heat pipe test vehicle for data acquisition was designed, fabricated, and bench model tests have been completed. A test vehicle is ready for field tests in sulfur plants and coal gasifiers.

(HEAT RECOVERY, CORROSION RESISTANCE, HEATING EQUIPMENT, MATERIALS)

HP78 22002 HEAT PIPE CENTRAL SOLAR RECEIVER

Bienert, W.B., (Sandia Labs., Albuquerque, NM), Highlights report solar thermal conversion program central power projects, Mar 1977, SAND--77-8011

A solar-to-gas heat exchanger for a central receiver power plant is discussed. Three potential receiver configurations and typical wick structures for the heat pipes under development are shown. The performance of the tent wick heatpipe is presented. A conceptual design of a test module with a capacity of 1 MWT is sketched.

(SOLAR-THERMAL CONVERSION, SOLAR-GAS HEAT EXCHANGER)

HP78 22003 HEAT PIPE CENTRAL SOLAR RECEIVER, SEMIANNUAL PROGRESS REPORT, MARCH 1, 1976 - AUGUST 31, 1976

Bienert, W.B., Wolf, D.A., (Dynatherm Corp., Cockeysville, MD), Nov 1976
Avail:TAC

The objective of this program is the development of a solar-to-gas heat exchanger for a central receiver power plant. The concept is based on the use of heat pipes to transfer the concentrated solar flux to the gaseous working medium of a Brayton cycle conversion system. An open air cycle with recuperator and a turbine inlet temperature of 800°C (approximately 1500°F) was selected as the optimum choice. It yields a conversion efficiency of approximately 32 percent and an overall solar-to-electric efficiency of 20 percent. The light weight of gas turbine equipment opens the possibility of tower mounting the entire system. Three potential receiver configurations have been identified, two of them being of the cavity type and one being an external receiver. The required thermal diffuser heat pipes use liquid metal as being of the cavity type and one being an external receiver. The required thermal diffuser heat pipes use liquid metal as the working fluid. The optimum size is approximately 5 CM in diameter and 2 to 3 M in length. The design axial heat flux is 10 MW/M^2 which corresponds to a heat transfer rate of 20 KW per heat pipe. The theoretical foundations of these heat pipes have been developed and subscale prototypes have been tested successfully. The radial and axial heat fluxes of the prototypes met and exceeded the requirements for the full-scale heat pipes.

(BRAYTON CYCLE, HEAT-PIPE TESTING, HEAT TRANSFER)

HP78 22004 HEAT TRANSPORTATION BY HOT WATER PIPE-LINES AT 90 DEGREES CENTIGRADE

Bourguet, J.M., Fischer, H., Lancal, L., (Joint Publications Research Service, Arlington, VA), Transl. Into English From Tech. De L'energie (France), p. 14-18, N1, 1976, AD-A038301, CRREL-TL-576, N77-28453
Avail:TAC

This report describes the possibility of transporting heat produced by nuclear power plants for urban heating distribution systems by means of water at 90°C.

(DISTRICT HEATING, URBAN PLANNING, HEAT-PIPE HEAT RECOVERY)

HP78 22005 ENERGY SAVING AND AIR POLLUTION CONTROL (WASTE HEAT RECOVERY FROM INCINERATORS)

Burke, B., HANDV News, V 20:30-1, 33, 36, N6, June 1977
Avail:TAC

No abstract available

(WASTE-HEAT RECOVERY, HEAT-PIPE RECUPERATOR)

HP78 22006 HEAT RECOVERY PAYBACK

Casey, C.S., (Isothermics, Inc., Augusta, NJ), Build Syst. Des., V 74:53-56, N3, 1977
Avail:TAC

The performance and economics of heat pipe heat recovery equipment, particularly for institutional space heating and ventilation, are discussed. A numerical example of payback considering savings affected in electric power, fuel oil, or natural gas consumption is included. It is concluded that heat pipe heat recovery systems are desirable and profitable.

(SPACE HEATING, VENTILATION, INSTITUTIONAL EQUIPMENT)

HP78 22007 EVALUATION OF THE USE OF HEAT PIPES IN TOKAMAK FUSION REACTORS

Chi, J.W.H., (ERDA, Washington, DC), (Westinghouse Electric Corp., Pittsburgh, PA), Technology of Controlled Nuclear Fusion, Volume II, 1976
Avail:TAC

The use of heat pipes appears to have the potential for solving difficult heat transport problems in tokamak fusion reactors. An analysis was carried out to evaluate the possible working fluids. The results suggested the use of sulphur and phosphorus. However, the effect of nuclear radiation on these materials is unknown and may present a problem.

(REACTOR COOLING, HEAT-PIPE TEMPERATURE CONTROL)

HP78 22008 ANALYSIS, DESIGN, AND THERMAL PERFORMANCE TESTING OF A HEAT PIPE FLAT PLATE COLLECTOR

Evans, R.D., Greeley, D.N., (Florida Technological Univ., Orlando, FL), American Section of the International Solar Energy Society, Cape Canaveral, FL, Proceedings of the 1977 Annual Meeting of the American Section of the International Solar Energy Society, V 1, Sect 1-13, 1977, Beach, C., Fordyce, E., eds.

The analysis, design and thermal performance data is presented for a solar heat pipe flat plate collector. A theoretical model for a heat pipe collector is presented and can be used to predict the thermal performance of such a solar energy collection device. A discussion of the design of a prototype solar collector utilizing circular heat pipes bonded to an absorber plate is presented. Preliminary performance data is presented for the prototype collector. The results of the thermal performance experiments indicate that heat pipes can function as the heat transfer elements in a solar collector. However, the experiments verify the criticality of the thermal resistances between the heat pipes, absorber plate and the heat pipe, collection manifold device.

(THEORETICAL MODEL, THERMAL TEST DATA, HEAT TRANSFER ELEMENTS)

HP78 22009 STUDY OF TECHNICAL OPTIONS AVAILABLE FOR RECLAIMING HEAT LOST TO THE ATMOSPHERE FROM EXISTING MECHANICAL DRAFT COOLING TOWERS Final Report

(Gordian Associates, Inc., New York, NY), Nov 1976, PB-261752

This report investigates options available for the recovery of wasteheat currently lost to the atmosphere from mechanical draft cooling towers. It lists a variety of useful purposes to which the warm water may be put. The use of heat pipes for more efficient heat exchange is described.

(WASTE HEAT RECOVERY, WASTE HEAT UTILIZATION)

HP78 22010 VAPIPE - A PRACTICAL SYSTEM FOR PRODUCING HOMOGENEOUS GASOLINE-AIR MIXTURES

Harrow, G.A., Mills, W.D., Thomas, A., Finlay, I.C., (Shell Res Ltd, Chester, England), SAE Prepr, 16 p., N760564 for Meet, June 7-10, 1976

The Vapipe is a device that has been developed jointly by Shell Research Limited, Thornton Research Centre, and the National Engineering Laboratory to reduce car exhaust emissions and improve fuel economy. It achieves better mixing of the charge entering the engine by vaporizing the gasoline in the inlet system. Heat for this purpose is conveyed from the exhaust system by means of a heat pipe. Two Vapipe systems have been tested, one in which surplus heat from the exhaust is rejected to the cooling system of the car and the second in which the boiler efficiency is varied to maintain the correct flow of heat to the fuel vaporizer. Both systems operate well but the latter is very much cheaper to make than the former. The Vapipe provides good mixture distribution and allows the engine to run smoothly at weak mixtures, thus permitting improvements in fuel economy and reductions in exhaust emissions. Substantial benefits have been obtained in practical installations, but these could be even greater if carburetters or other fuel-metering devices were developed to take maximum advantage of the homogeneous mixtures. Significant improvements in engine warm-up time, driveability, and flexibility of opera;tion are also achieved but power output is somewhat reduced.

(AUTOMOBILE ENGINES, FUEL ECONOMY, HEAT-PIPE FUEL VAPORIZER)

HP78 22011 ENERGY RECOVERY SYSTEMS FOR HOSPITAL USE

Kensett, R.G., (Welsh Health Tech. Services Organization, Cardiff, Wales), Hosp. Eng., V 30:3-12, July 1976
Avail:TAC

No abstract available

(HOSPITAL ENGINEERING, THERMAL WHEEL, HEAT-PIPE RECUPERATOR)

HP78 22012 APPLICATION OF HEAT PIPES TO GROUND STORAGE OF SOLAR ENERGY

Kroliczek, E.J., (B & K Engineering, Inc., Towson, MD), Yuan, S.W., Bloom, A.M., (George Washington University, Washington, DC), American Institute of Aeronautics and Astronautics Thermophysics Conference, 12th, Albuquerque, NM, AIAA paper 77-729, 6 p., June 27-29, 1977, A77-39507

A heat pipe concept design for application to residential solar energy storage has been developed. The basic feasibility of the concept has been demonstrated in prototype testing at George Washington University. The design incorporates the simplicity and high efficiency of the heat pipe together with current heat pipe thermal control techniques and an external pump a-sist for liquid return against gravity. As configured the heat pipe system provides the capability of transferring heat from solar collectors to an energy storage area and points of utilization within a single heat transfer element. All control functions are inherent in the heat pipe construction including automatic shutdown of the solar collector zone when positive net energy flow is not achieved. Pumping power requirements are minimal and needed only during solar input periods. Future designs could utilize solar energy to drive the pump. Finally, the heat pipe system can be interfaced with any one or combination of household heat transfer mediums including air, hot water or working fluids from air conditioners or heat pumps. This paper describes the concept, the details of a prototype design and the results obtained with a simulated ground storage test system.

(HEAT-PIPE HEAT RECOVERY, ENVIRONMENTAL CONTROL, DESIGN)

HP78 22013 SOME ASPECTS OF NATURAL GAS CONSERVATION

Proffitt, R., (British Gas Corp., London, England), Gas Eng. Manage., V 17:180-194, N 6, June 1977, EDB-78-02

It is shown how the energy supply and utilization situation has changed over the years, necessitating the urgent action for fuel conservation. Figures taken from official sources underline the reasons in addition to fuel prices why the situation has caused the government to embark on an extremely expensive publicity campaign 'save it.' Combustion of natural gas is considered, and a flue loss chart is developed. This flue loss chart is simple to use, showing at a glance the thermal efficiency of plant from simple flue gas information. British gas is making a large and valuable contribution to natural gas conservation in many directions such as leakage control on mains, technical consultancy service, education of customers in fuel utilization and with developments for industrial utilization (self-recuperative burner, rapid metal heaters, etc.). In practical terms, items of plant can be utilized more efficiently and care can be taken in planning production. The use of new devices, i.e., thermal wheels and heat pipes, provides new tools to help the fuel engineer conserve energy.

(ENERGY CONSERVATION, FLUE GAS, SELF-RECUPERATIVE BURNER, METAL HEATERS)

HP78 22014 THE HEAT PIPE HEAT EXCHANGER: A TECHNIQUE FOR WASTE HEAT RECOVERY

Reay, D.A., (Internat. Res. and Dev. Co. Ltd., Fossway, Newcastle Upon Tyne, England), Heat and Vent. Eng. (GB), V 50:7-9, N594, 2 refs, Jan 14, 1977
Avail:TAC

No abstract available

(PROCESS HEAT, SPACE HEATING, HEAT EXCHANGER)

HP78 22015 HEAT PIPE APPLIANCES

Rice, J.F., (Southern California Gas Company, Los Angeles, CA), Searight, E.F., (Research Triangle Inst., Research Triangle Park, NC), Ayer, F.A., Symposium on Environment and Energy Conservation, Aug 1976, EPA-600/2-76-212

Recent awareness of the extent of energy shortages in this country has increased the recognition of the necessity of designing appliances which are capable of providing significant reductions in energy consumption. This should, however, be accomplished without sacrificing the ecological objective of reducing emission of toxic gases or vapors. The heat pipe appliances discussed accomplish these objectives. Heat pipes have been combined with forced combustion and jet impingement heat transfer to produce a group of gas-fired residential and commercial appliances. These appliances utilize the isothermal characteristics of heat pipes together with the inherent high efficiency and low emissions of forced combustion systems to provide improved performance compared to contemporary equipment. Included in these appliances are a commercial griddle, an oven for reconstitution of frozen foods, a deep fat fryer, and a water heater, typical test data for these appliances show carbon monoxide levels of 10 to 100 PPM and total oxides of nitrogen concentration of 5 to 20 ppm. Cooling efficiency for the oven was improved from less than 42% for conventional equipment to 54%. For the water heater, both operating and standby losses were reduced with the combustion efficiency increased from 70% to over 80%. Similar improvements were accomplished for the other appliances. These appliances illustrate that heat pipes can be applied in useful and practical designs to provide products with significant advantages over conventional appliances. Including improvements in efficiency and emissions, while providing uniformity of temperature and better temperature control.

(ENERGY CONSERVATION, TEMPERATURE CONTROL, TEMPERATURE UNIFORMITY)

HP78 22016 STUDY OF THE CHARACTERISTICS OF CONVECTIVE HEAT TRANSFER IN CYLINDRICAL SOLAR ENERGY RECEIVERS BY SOLVING THE CONJUGATE PROBLEM OF HEAT EXCHANGE

Rozhov, I.A., Grilikhes, V.A., Geliotekhnika, p. 56-63, N2, 1977, A77-37771, In Russian

No abstract available

(HEAT-PIPE SOLAR COLLECTORS, SOLAR ENERGY CONVERSION, BOUNDARY VALUE PROBLEM)

HP78 22017 AEROSPACE AND HVAC&R SPINOFF 1977 - REAPING THE DIVIDENDS - HEATING, VENTILATION, AIR CONDITIONING, AND REFRIGERATION

Ruzic, N.P., (NSI, Washington, DC), ASHRAE Journal, V 19:30-35, Aug 1977, A77-45918
AVAIL:TAC

Industrial applications of U.S. space technology are discussed. Topics include aerial reconnaissance thermograms to determine heat losses from buildings, capillary heat pipes used to insulate oil pipelines or recover heat from chimney flue losses, analyses of materials subject to high-temperature stress, analyses of creep fatigues, computerized design aids for fans, heat exchangers and piping systems, aluminized mylar insulation, solar cells and collectors, and fuel cells. NASA Industrial Applications Centers, where technical information is made available to the public, are listed; the availability of patents for licensing is also discussed.

(CAPILLARY HEAT-PIPES, WASTE HEAT RECOVERY)

HP78 22018 TWO-PHASE WORKING FLUIDS FOR THE TEMPERATURE RANGE 100-350°C - IN HEAT PIPES FOR SOLAR APPLICATIONS

Saaski, E.W., (Sigma Research, Inc., Richland, WA), Tower, L., (NASA, Lewis Research Center, Cleveland, OH), American Institute of Aeronautics and Astronautics Thermophysics Conference, 12th, Albuquerque, NM, AIAA paper 77-753, 8 p., June 27-29, 1977, NASA supported research, A77-37266
Avail:TAC

The decomposition and corrosion of two-phase heat transfer liquids and metal envelopes have been investigated on the basis of molecular, bond strengths and chemical thermodynamics. Potentially stable heat transfer fluids for the temperature range 100 to 350°C have been identified, and reflux heat pipe tests initiated with 10 fluids and carbon steel and aluminum envelopes to experimentally establish corrosion behavior and noncondensable gas generation rates.

(REFLUX HEAT-PIPE, CARBON STEEL ALUMINUM, GAS GENERATION)

HP78 22019 SOLAR RESIDENTIAL ELECTRIFICATION WITH HIGH PERFORMANCE HEAT ENGINES

Salter, R.M., (American Institute of Aeronautics and Astronautics, NY), 1975
Avail:TAC

Application of high-performance closed-cycle heat engines to solar energy conversion for residences and other buildings is considered. Stirling and recuperated Brayton cycles are investigated with the former favored due to commonality in construction with conventional small Otto cycle engines. Typical top temperatures of these cycles are near best compromise between thermodynamic efficiency vs. solar collection efficiency. The overall system includes an array of sun-following paraboloidal collectors connected by sodium heat pipes. Both heat and electrical buffering, control problems, accoutrements (such as heat pumps), other heat sources, and other electrical sources are examined. Analogous conversion of furnace fuel energy into electricity is considered.

(BRAYTON CYCLE, STIRLING ENGINE, PARABOLIC REFLECTORS)

HP78 22020 RECLAIMING DIRTY EXHAUST HEAT

Schultz, G.V., Fact Manage, V 10:15-17, N2, Feb 1977
Avail:TAC

Shop air contains contaminants. Some are carcinogenic or toxic. But a NIOSH-sponsored study shows that 356 out of 514 compounds can be recirculated for plant energy savings. Two distinct solutions have recently appeared. The first continues to expell process-contaminated air from the building, while adding on some kind of heat transfer device to warm cold makeup air. The second contains warm air within the building (or cool air, if it's summer), relying on mechanical or electronic cleaners to safely recycle it. The first type includes: heat recovery wheels, exchanges that can recovery and process up to 80% of exhaust stream energy and can handle corrosive environments and temperatures to 1500°F; static air-to-air heat exchangers surrounding the exhaust-air duct, using conduction to transfer energy without cross-contamination and at an efficiency approaching 80%; heat pipes; recuperators. The second approach includes dry centrifugal air cleansers (their limitation is particles below 10 μ m); wet collectors, including scrubbers; fabric collectors (good for both large and small particulates); electrostatic precipitators, which can treat smoke, dust, fumes, or oil mist, capturing about 99% of airborne particulates from 0.01 m μ to 100 μ m. Several examples of applications of these systems are described.

(WASTE HEAT RECOVERY, HEAT-PIPE HEAT EXCHANGERS)

HP78 22021 MODELING OF A HEAT-PIPE OPERATED THERMAL STORAGE DEVICE

Yang, W.J., Lee, C.P., (Univ. of Michigan, Ann Arbor, MI), ASHRAE Trans., V 82:634-643, 1976
Avail:TAC

An explicit finite-difference formulation is applied to simulate the dynamic performance of fusion-type thermal storage devices operated by heat pipes. The condensation part of the heat pipe is embedded in the storage unit, while the evaporation end is inserted in the solar collector or in the solar loop. Consideration is given to salt hydrates and eutectic fluoride mixtures of alkali and alkaline earth metals as storage materials in the vessel of cylindrical or spherical construction. Numerical results are obtained by means of a digital computer for the transient response of the storage medium to a step change in the heat-carrier temperature in the heat pipe. The dimensionless physical parameters governing the dynamic characteristics of the heat storage unit are identified and their roles determined. The formulation is general and may be applied to investigate other types of thermal response of the storage systems.

(EUTECTICS, FUSION HEAT, NUMERICAL SOLUTION, THERMAL STORAGE)

HP78 22022 TUBULAR EVACUATED SOLAR COLLECTOR UTILIZING A HEAT PIPE AS ABSORBER

Ortabasi, U., (Corning Glass Works Research and Development Laboratories, Corning, NY), Cooperation Mediterraneenne Pour L'Energie Solaire, Revue Internationale D'Heliotechnique, p. 14-17, N2, 1976, E(11-1)-2608, A77-42961
Avail:TAC

A heat pipe evacuated tubular solar collector has been built and tested. Based on the present design, it performs somewhat less efficiently than a flat plate in a vacuum for temperatures less than 125°F. However, its performance is less dependent on the temperature of operation so that it performs better at temperatures greater than 125°F. Improvements may be possible given better mirror fabrication, heat pipe design, and antireflection coatings.

(CONVECTIVE HEAT TRANSFER, ENERGY CONVERSION)

HP78 22023 METHANATION: WITH HIGH THERMODYNAMIC EFFICIENCY ENERGY RECOVERY

Biery, J.C., (Los Alamos Scientific Lab, NM), 28 refs, Jan 1977

Heat pipes could be utilized in the process of methanating synthesis gas from coal in two important ways. The first is in the methanator itself where the heat pipes are used for catalyst cooling, temperature control, and high-temperature isothermal energy recovery. The second involves recovering thermal energy in the exit gas stream from the methanator and using it to preheat the methanator inlet stream and also to produce steam from condensed water from the exit stream. The methanator has the following unique characteristics. It is composed of a dense assembly of heat pipes with stacks of cylindrical pellets of a catalyst such as $NiAl_2O_3$ intimately dispersed among them. Nickel concentration in the catalyst stacks is varied from 10 to 50 percent to limit the front end temperature within the methanator. Heat is extracted from the methanation reaction isothermally at temperatures approaching the upper operating limits of the catalyst - approximately 750 to 800°K. Energy is transported by the heat pipe into a steam boiler where superheated steam is produced. The post methanation recuperator is a unique three-chamber recuperator heat exchanger. Energy is transported between the inlet and outlet gas streams from the methanator in the lower chambers interconnected with heat pipes. In the upper chamber condensed water from the exit gas stream is transferred either to the inlet stream or to steam from the condensed water. Costs of the methanator and the recuperator appear to be somewhat lower than comparable units designed by El Paso Natural Gas Co., for their methanation plant at the Four Corners area. The extraction of the heat isothermally at high temperature and the efficient recuperation of the energy between the inlet and outlet gas streams make the present unit attractive.

(METHANATION, COAL GASSIFICATION, CATALYST COOLING)

HP78 22024 DEMAND SENSITIVE ENERGY STORAGE IN MOLTEN SALTS

Nemeck, J.J., Simmons, D.E., Chubb, T.A., (Naval Research Lab., Washington, DC), American Section of the International Solar Energy Society, Cape Canaveral, FL, Sharing the Sun: Solar Technology in the Seventies, V 8, 1976, Boeer, K.W., ed.

Heat-of-fusion energy storage and on-demand steam are obtained using heat pipe techniques to transfer heat to and from stacked salt cans and onto boiler tubes within a sealed "energy storage-boiler" tank for solar thermal power plants.

(HEAT-OF-FUSION, ENERGY STORAGE, ENERGY STORAGE-BOILER, SALTS)

II. D. AEROSPACE APPLICATIONS

HP78 23000 CONCEPTUAL DESIGN OF A HEAT PIPE RADIATOR

Bennett, G.A., (Los Alamos Scientific Lab., NM), Sept 1977, LA--6939-MS

A conceptual design of a waste heat radiator has been developed for a thermoelectric space nuclear power system. The basic shape of the heat pipe radiator was a frustum of a right circular cone. The design included stringer heat pipes to carry reject heat from the thermoelectric modules to the radiator skin that was composed of small-diameter, thin-walled cross heat pipes. The stringer heat pipes were armored to resist puncture by a meteoroid. The cross heat pipes were designed to provide the necessary unpunctured radiating area at the mission end with a minimum initial system mass. Several design cases were developed in which the individual stringer survival probabilities were varied and the radiator system mass was calculated. Results are presented for system mass as a function of individual stringer survival probability for six candidate container materials, three candidate heat pipe fluids, two radiator operating temperatures, two meteoroid shield types, and two radiating surface cases. Results are also presented for radiator reject heat as a function of system mass, area, and length for three system sizes.

(THERMOELECTRIC, NUCLEAR-SPACE POWER, CONCEPTUAL DESIGN)

HP78 23001 DEVELOPMENT AND QUALIFICATION OF PCM THERMAL CAPACITORS, PART 2. DEVELOPMENT OF PCM THERMAL CAPACITOR PLATFORMS AND PCM THERMAL CAPACITOR RADIATORS - SATELLITE TEMPERATURE CONTROL. Final Report

Blaser, P., Hauser, G., Strittmatter, R., (Bonn Bundesmin. Fuer Forsch. U Technol., Germany),(Dornier-System G.M.B.H., Friedrichshafen, West Germany), 129 p., BMFT-FB-W-76-27-VOL-2, BMFT-WRT-2073/01A0423, N77-26437, In German; English summary

Results of a development program which deals with theoretical and experimental investigations of phase change thermal capacitors for space application are described. Different types of thermal design with latent enthalpies between 120 and 380 W-H and an operational temperature of about 26^{o}C were examined. The following frequent heat power profiles were considered: variable power, eclipse, and variable power combined with radiation. Besides filler structures previously qualified, a new thermal transport structure using heat pipes was investigated.

(PHASE TRANSFORMATION, TEMPERATURE CONTROL, THERMAL CAPACITORS)

HP78 23002 INSTRUMENT CANISTER THERMAL CONTROL - FOR SPACE SHUTTLE-BORNE EXPERIMENTS

Harwell, W., Haslett, R., (Grumman Aerospace Corp., Bethpage, NY), Ollendorf, S., (NASA, Goddard Space Flight Center, Greenbelt, MD), American Institute of Aeronautics and Astronautics, Thermophysics Conference, 12th, Albuquerque, NM, AIAA paper 77-761, 10 p., June 27-29, 1977, A77-37272

Avail:TAC

A transient thermal analysis and test of a thermal control canister is described. The 1 x 1 x 3 M canister provides a uniform thermal environment for shuttle instrument payloads requiring fine temperature control, the design goal being operation between 0^{o}C and 20^{o}C with a range of plus or minus 1^{o}C at any selected set-point temperature. The canister side walls are isothermalized by a system of longitudinal and circumferential heat pipes rejecting heat through feedback controlled, variable conductance heat pipes to side mounted radiators. A breadboard model of two side walls and two radiators was tested in a thermal vacuum chamber. The breadboard was stable over a wide range of effective environments, experiment dissipations, and control point temperature levels.

(BREAD BOARD MODEL, MATHEMATICAL MODEL, DESIGN ANALYSIS)

HP78 23003 STUDY ON THE FEASIBILITY OF STRUCTURAL THERMAL CANISTER FOR THE INSTRUMENT POINTING SUB-SYSTEM OF THE SPACELAB, VOLUME 2. Final Report

Hoppe, U., Kreeb, H., Nickel, H., Heidt, F.D., Staatsmann, H., Koch, H., Perdu, M., (Dornier-System G.M.B.H., Friedrichshafen, West Germany), ESP-CR(P)-922-VOL-2, ESA-2817/76/P/WMT(SC), N77-26220

Avail:TAC

A canister was studied for the precision pointing facility IPS (used for spacelab experiments). This canister has to provide a mounting and thermally controlled environment for a set of individually not controlled experiments. A cost evaluation is given for the total canister as well as for the thermal and structural subsystems, based on the heat pipe radiator solution selected.

(HEAT-PIPE RADIATOR, INSTRUMENT ORIENTATION, STRUCTURAL ANALYSIS)

HP78 23004 FUSIBLE HEAT SINK FOR A CRYOGENIC REFRIGERATOR

Kroebig, H.L., (Department of this Air Force, Washington, DC), Jan 12, 1977, AD-D--003515, EDB-77-22

A fusible heat sink for a cryogenic refrigerator used to provide cooling for a detector in the guidance system of a missile is described. The cryogenic refrigerator has a cold cylinder in contact with the detector and a hot cylinder. The hot cylinder and cold cylinder are connected to a crankcase housing. A heat pipe is connected between the crankcase and the missile skin for providing primary cooling for the crankcase housing. The fusible heat sink is connected to the crankcase with the crankcase forming part of the wall of the heat sink housing. A fusible material is located within the housing. The inside surface of the heat sink housing is coated with nickel and silver to increase the heat transfer between the crankcase and the heat sink.

(MISSILE GUIDANCE, COOLING, COATING, NICKEL, SILVER)

HP78 23005 A PRECISE SATELLITE THERMAL CONTROL SYSTEM USING CASCADED HEAT PIPES

Steele, W.H., (McDonnell Douglas Astronautics Co., St. Louis, MO), McKee, H.B., (Frito-Lay, Inc., Irving, TX), American Institute of Aeronautics and Astronautics, Thermophysics Conference, 12th, Albuquerque, NM, AIAA paper 77-777, 12 p., June 27-29, 1977, A77-37282
Avail:TAC

A cascaded, dry reservoir, variable conductance heat pipe system was tested. Results show passive temperature control within plus or minus 0.5°F of the desired set point for a wide range of heat input and effective space environment temperatures. The use of long capillary tubes to isolate the reservoir and prevent set point temperature change due to cyclic heat loads and/or cyclic environment temperature was demonstrated. Orbit set point temperature control feasibility was investigated using variable volume control gas reservoirs. Set point temperature adjustment over a range from 50°F to 90°F was successfully achieved with high control accuracy.

(CASCADE FLOW, WORKING FLUIDS, CYCLIC LOADS)

HP78 23006 NEW AVIONICS THERMAL CONTROL CONCEPT

Token, K.H., (McDonnell Aircraft Co, St Louis, MO), ASME Pap, 10 p., N77-ENAs-14 for Meet, 5 refs, July 11-14, 1977
Avail:TAC

This paper describes a heat pipe-liquid cooling concept for avionic system cooling which exhibits higher thermal efficiency than currently used cooling techniques. The new heat pipe cooling concept allows higher temperature coolants to maintain avionic components at lower operating temperature, thereby increasing avionic reliability and reducing aircraft weight penalties incurred by the cooling sytem. Key technical developments required for the implementation of the new cooling technique are identified. Measured thermal performance for small heat pipes which were developed for the new cooling system are presented.

(ELECTRONIC EQUIPMENT, WEIGHT REDUCTION)

HP78 23007 THE MULTISTAGE HEAT PIPE RADIATOR - AN ADVANCEMENT IN PASSIVE COOLING TECHNOLOGY

Wilson, D.E., Wright, J.P., (Rockwell International Corp., Downey, CA), American Institute of Aeronautics and Astronautics, Thermophysics Conference, 12th, Albuquerque, NM, AIAA paper 77-760, 13 p., June 27-29, 1977, NAS8-31324, N77-37271
Avail:TAC

Mathematical models were developed for one-, two-, and three-stage radiator systems to determine optimum stage areas and system performance as a function of such parameters as insulation effectiveness, cold stage temperature, and heat load to the cold and intermediate stages. This study shows that multistage radiator systems can be optimized on the basis of weight or projected area, and that cold stage temperature as low as 15°K are theoretically possible with present technology levels for insulation emittance. For the baseline design, analyses were performed to determine optimum radiator fin geometry and heat pipe spacing as a function of temperature, material properties, and heat pipe weight. In addition, a ground test system was designed for the baseline design with heat rejection requirements of 10 MW at 35°K on the cold stage and 100 MW at the second stage.

(MATHEMATICAL MODEL, OPTIMIZATION, GROUND-TEST SYSTEM)

HP78 23008 LOW-TEMEPRATURE HEAT PIPES FOR AIRCRAFT - RUSSIAN BOOK

Voronin, V.G., Reviakin, A.V., Sasin, V.I., Tarasov, V.S., Moscow, Izdatel'Stvo Mashinostroenie, 200 p., 1976, A77-43612, In Russian

The theoretical basis of heat and mass transfer processes in low-temperature heat pipes operating at temperatures from minus 200 to plus 300°C is presented. Methods used to predict the parameters of heat pipes with different configurations and different conditions of operation are outlined. The construction and control of heat pipes are discussed, and present and possible future applications of heat pipes in aircraft and spacecraft in heat regulation, air conditioning, and life support systems are considered.

(LIFE SUPPORT SYSTEMS, TEMPERATURE CONTROL)

HP78 23009 RE-ENTRANT GROOVE HEAT PIPE - COMPUTERIZED DESIGN FOR OAO APPLICATIONS

Harwell, W., Kaufman, W.B., Tower, L.K., (Grumman Aerospace Corp., Bethpage, NY), (NASA, Lewis Research Center, Cleveland, OH), American Institut of Aeronautics and Astronautics, Thermophysics Conference, 12th, Albuquerque, NM, AIAA paper 77-773, 9 p., June 27-29, 1977, A77-37280
Avail:TAC

This paper describes theoretical and experimentally verified heat pipe characteristics of an axially grooved aluminum extrusion with a re-entrant groove profile. The extrusion is 13 MM diameter with 20 axial grooves, each groove consisting of a nominal .8 MM diameter channel with a .2 MM wide passageway connecting the channel to the hollow core. A computer program was written to compute the zero gravity heat transport capability of the extrusion. A heat pipe was fabricated and its performance characteristics measured. The characteristics of the pipe with ammonia at 20°C are zero gravity pumping limit 140 W-METERS; static wicking height 21.5 MM; evaporator and condenser coefficients 7200 and 20,500 WATT/SQ M C, respectively.

(ZERO GRAVITY, HEAT TRANSPORT CAPABILITY, ZERO GRAVITY)

II. B. ELECTRICAL AND ELECTRONIC APPLICATIONS

HP78 24000 THERMAL CONTROL OF POWER SUPPLIES WITH ELECTRONIC PACKAGING TECHNIQUES Final Report

(Martin Marietta Corp., Denver, CO), Feb 1977, N77-18386

The integration of low-cost commercial heat pipes in the design of a NASA candidate standard modular power supply with a 350 W output resulted in a 44% weight reduction. Part temperatures were also appreciably reduced, increasing the environmental capability of the unit. A complete 350 W modular power converter was built and tested to evaluate thermal performance of the redesigned supply.

(MODULAR POWER SUPPLY, WEIGHT REDUCTION, TEST, EVALUATION)

III. HEAT PIPE THEORY

III. A. GENERAL

HP78 30000 STUDY OF HEAT AND MASS TRANSFER IN A HEAT PIPE BY MEANS OF A MATHEMATICAL MODELING METHOD

Avakian, I.N., Kulagin, I.I., Sheludko, O.V., (Severo-Zapadnyi Politekhnicheskii Institut, Leningrad, USSR), In Heat and Mass Transfer - V; All-Union Conference on Heat and Mass Transfer, 5th, Minsk, Belorussian SSR, May 17-20, 1976, Proceedings, Minsk, An BSSR Institut Teplo- I Massoobmena, V 3:211-215, Pt 2, 1976, (A77-43880 20-34), A77-43947, In Russian

A block diagram is presented for a mathematical model of the operation of a coaxial heat pipe, used for removal of heat from a cylindrical body. The optimal regime for initiating the pipe conditions is determined as the regime of its heating during which the pipe goes into a stationary state after a minimal time 'without overburn'. Functions are introduced for ascertaining this regime, and a method for determining the temperature, moisture content, and pressure of the wick is described. Heat and mass transfer for a sodium heat pipe is analyzed.

(COAXIAL HEAT-PIPE, SODIUM, HEAT TRANSFER)

HP78 30001 PREDICTION OF CRYOGENIC HEAT PIPE PERFORMANCE - Final Report

Colwell, G.T., (Georgia Inst. of Tech., Atlanta, GA, School of Mechanical Engineering), NASA-CR-152770, 109 p., NSG-2054, N77-76447
Avail:TAC

No abstract available

(PREDICTION ANALYSIS, THERMAL PERFORMANCE)

HP78 30002 RE-ENTRANT GROOVE HEAT PIPE - COMPUTERIZED DESIGN FOR OAO APPLICATIONS

Harwell, W., Kaufman, W.B., Tower, L.K., (Grumman Aerospace Corp., Bethpage, NY), (NASA, Lewis Research Center, Cleveland, OH), American Institut of Aeronautics and Astronautics, Thermophysics Conference, 12th, Albuquerque, NM, AIAA paper 77-773, 9 p., June 27-29, 1977, A77-37280
Avail:TAC

This paper describes theoretical and experimentally verified heat pipe characteristics of an axially grooved aluminum extrusion with a re-entrant groove profile. The extrusion is 13 MM diameter with 20 axial grooves, each groove consisting of a nominal .8 MM diameter channel with a .2 MM wide passageway connecting the channel to the hollow core. A computer program was written to compute the zero gravity heat transport capability of the extrusion. A heat pipe was fabricated and its performance characteristics measured. The characteristics of the pipe with ammonia at 20°C are zero gravity pumping limit 140 W-METERS; static wicking height 21.5 MM; evaporator and condenser coefficients 7200 and 20,500 WATT/SQ M C, respectively.

(ZERO GRAVITY, HEAT TRANSPORT CAPABILITY, ZERO GRAVITY)

HP78 30003 HEAT PIPE: THEORY AND PERFORMANCE CHARACTERISTICS

Jog, V., Mujumdar, A.S., (McGill Univ., Montreal, Canada), J. Inst. Eng. (India), Chem. Eng. Div., V 57:78-82, N2, Feb 1977
Avail:TAC

Efficient and economic transfer of thermal energy from one location to another has always been a major problem facing engineers. A lightweight device with no moving parts, high efficiency and long-life expectancy - called heat pipe - seems to be ideal for several such applications. It consists essentially of a hollow tube with a working fluid in a porous liner which covers the inside surface of the tube. The basic physical and operational features of the device and some areas of its application and inherent limitations are discussed.

(OVERVIEW, HEAT-PIPE THEORY)

HP78 30004 EFFECTS OF GRAVITY ON GAS-LOADED VARIABLE CONDUCTANCE HEAT PIPES

Kelleher, M.D., Batts, W.H., (Nav. Postgrad. Sch., Monterey, CA), Int. Heat Pipe Conf., Pap., 2nd, p. 255-234, 1976
Avail:TAC

No abstract available

(HEAT TRANSFER, MASS TRANSFER, DESIGN)

HP78 30005 THERMAL PIPES OF COMPLEX CONFIGURATION

Vasil'Ev, L.L., Konovalov, A.S., (Inst. of Heat and Ma-s Exchange, Minsk, USSR), Vestsi Akad. Navuk BSSR, Ser. Fix. - Energ. Navuk, V 3:110-114, 1976, In Russian

An approximate method for calculating a maximum power transferred by the complex-configuration heat pipe is proposed.

(POWER-TRANSFER, MATHEMATICAL APPROXIMATION)

HP78 30006 LOW-TEMEPRATURE HEAT PIPES FOR AIRCRAFT - RUSSIAN BOOK

Voronin, V.G., Reviakin, A.V., Sasin, V.I., Tarasov, V.S., Moscow, Izdatel'Stvo Mashinostroenie, 200 p., 1976, A77-43612, In Russian

The theoretical basis of heat and mass transfer processes in low-temperature heat pipes operating at temperatures from minus 200 to plus 300°C is presented. Methods used to predict the parameters of heat pipes with different configurations and different conditions of operation are outlined. The construction and control of heat pipes are discussed, and present and possible future applications of heat pipes in aircraft and spacecraft in heat regulation, air conditioning, and life support systems are considered.

(LIFE SUPPORT SYSTEMS, TEMPERATURE CONTROL)

HP78 30007 THEORETICAL CONSIDERATIONS ON THE HEAT PIPE

Zimmermann, P., (Stuttgart University, Germany), Inst Fuer Kernenergetik, Oct, 1976
Avail:NTIS

The physical principles of the heat pipe are presented with the surface stress considered. The possibility of formation of steam bubbles is studies. For networks and grooves, relations are established giving the cross-section of the fluid as a function of the hydraulic capillary diameter. For networks and grooves the maximum possible suction stresses are determined.

(STEAM BUBBLE FORMATION, SUCTION STRESS, HYDRAULIC CAPILLARY DIAMETER)

HP78 30008 IKEPIPE - A PROGRAMME FOR THE CALCULATION OF HEAT PIPES

Hage, M., (Stuttgart University, Germany), Inst Fuer Kernenergetik, July 1976, In German
Avail:NTIS

The computing program IKEPIPE at hand calculates the maximum capacity to be transferred by a heat pipe in dependence of working temperature and tilt height or angle of inclination. These calculations can be carried out for various types of heat pipes using different heat carriers. The first version of the programme at hand only calculates the transfer capacity for saturated capillary structures.

(COMPUTER PROGRAM, SATURATED CAPILLARY STRUCTURES, FLUID FLOW)

HP78 30009 THE MULTISTAGE HEAT PIPE RADIATOR - AN ADVANCEMENT IN PASSIVE COOLING TECHNOLOGY

Wilson, D.E., Wright, J.P., (Rockwell International Corp., Downey, CA), American Institute of Aeronautics and Astronautics, Thermophysics Conference, 12th, Albuquerque, NM, AIAA paper 77-760, 13 p., June 27-29, 1977, NAS8-31324, N77-37271
Avail:TAC

Mathematical models were developed for one-, two-, and three-stage radiator systems to determine optimum stage areas and system performance as a function of such parameters as insulation effectiveness, cold stage temperature, and heat load to the cold and intermediate stages. This study shows that multistage radiator systems can be optimized on the basis of weight or projected area, and that cold stage temperature as low as 15°K are theoretically possible with present technology levels for insulation emittance. For the baseline design, analyses were performed to determine optimum radiator fin geometry and heat pipe spacing as a function of temperature, material properties, and heat pipe weight. In addition, a ground test system was designed for the baseline design with heat rejection requirements of 10 MW at 35°K on the cold stage and 100 MW at the second stage.

(MATHEMATICAL MODEL, OPTIMIZATION, GROUND-TEST SYSTEM)

III. B. HEAT TRANSFER

HP78 31000 STATIC AND DYNAMIC CHARACTERISTICS OF GAS-FILLED HEAT PIPES DURING COMPLEX THERMAL EFFECTS

Beliakov, A.P., Platunov, E.S., (Leningradskii Institut Tochnoi Mekhaniki I Optiki, Leningrad, USSR), In Heat and Mass Transfer - V; All-Union Conference on Heat and Mass Transfer, 5th, Minsk, Belorussian SSR, May 17-20, 1976, Proceedings, Minsk, An BSSR Institut Teplo- I Massoobmena, V 3:223-227, Pt 3, 1976, (A77-43880 20-34). A77-43949, In Russian

Gas-filled heat pipes used as regulators perform the three functions of removing heat from an object, creating an internal isothermal zone, and maintaining temperature stability. Transfer functions are introduced for estimating output time of the heat pipe system and for obtaining allowable amplitude and frequency values of fluctuations of destabilizing effects. A mathematical analysis of a gas-filled heat pipe model is provided for static and dynamic conditions.

(DYNAMICS, THERMAL STABILITY, ERROR ANALYSIS, LAPLACE TRANSFORM)

HP78 31001 INVESTIGATION OF THE MAXIMUM HEAT-TRANSFER CAPACITY OF CLOSED TWO-PHASED THERMOSIPHONS

Bezrodnyi, M.K., Beloivan, A.I., (Kiev Polytech Inst. Ukr, USSR), J. Eng. Phys., V 30:377-383, N4, 9 refs, Apr 1976
Avail:TAC

The results of an investigation of the maximum heat fluxes transmitted by vertical two-phase thermosiphons as a function of their geometrical, physical, and regime parameters are presented. In this study an effort was made to determine how the heat-transfer capacity of the thermosiphon was affected by the following parameters: the diameter and length of the heat-input segment, the pressure of the intermediate coolant and the degree to which the inner cavity of the thermosiphon was filled with it, the nature of the working liquid, and the dimensions of the condenser.

(DESIGN PARAMETERS, FLUID FLOW, HEAT TRANSFER)

HP78 31002 CONTROL OF HEAT PIPES AND THERMOSIPHONS

Chisholm, D., (Nat. Engng. Lab., East Kilbride, Scotland), Heat Pipe Forum, p. 30-37, 8 refs, 1976, Glasgow, Scotland, Nat. Engng Lab., March 18, 1975, Glasgow, Scotland
Avail:TAC

No abstract available

(THERMAL VARIABLES, HEAT TRANSFER, GAS CONTROL, CIRCULATION CONTROL)

HP78 31003 HEAT EXCHANGE AND FRICTION IN A SUBSONIC VAPOR FLUX OF HIGH-TEMPERATURE HEAT PIPES

Fedorov, V.N., Sasin, V.Y., (Moscow Power Inst., USSR), J. Eng Phys, V 30:258-263, N3, Mar 3, 1976
Avail:TAC

The influence of forced vapor convection on heat transport in heat pipes is examined on the basis of the solution of the energy and motion equations. It is shown that radial heat flux due to molecular heat conduction of the vapor in the evaporator is negligible.

(FORCED CONVECTION, HEAT-TRANSFER, RADIAL HEAT-FLUX)

HP78 31004 AN EXPERIMENTAL AND THEORETICAL STUDY OF THE OPERATION OF A HEAT PIPE

Goriachko, I.G., Zhizhin, G.V., In Heat and Mass Transfer - V; All-Union Conference on Heat and Mass Transfer, 5th Minsk, Belorussian SSR, May 17-20, 1976, Proceedings, Minsk, An BSSR Institut Teplo- I Massoobmena, V 3:228-231, Pt 2, 1976, (A77-43880 20-34), A77-43950, In Russian

The temperature distribution and heat flux of a sodium heat pipe in supersonic flow conditions were determined and compared with the predicted results obtained by the unidimensional steady-state theory for a delivery nozzle with a dry vapor in it. Since a discrepancy was found, an improved mathematical procedure is presented, which takes into account the possibility of a two-phase structure of the flux.

(SODIUM, SUPERSONIC HEAT TRANSFER, MATHEMATICAL MODELS)

HP78 31005 AN ANALYTICAL STUDY OF THE MAXIMAL HEAT-CARRYING CAPACITY OF HEAT PIPES

Semena, M.G., Gershuni, A.N., Rassamakin, B.M., (Kievskii Politekhnicheskii Institut, Kiev, Ukrainian, USSR), Energetika, V 20:93-97, May 1977, A77-42260, In Russian

An analytical solution is obtained for determining the hydrodynamic limit of the heat-carrying capacity of a cylindrical heat pipe with an annular isotropic wick. The differential equation of fluid movement in the wick of the heat tube is solved by the separation of variables method using an orthogonalized basis. Experiments were conducted using water heat pipes with metal fiber wicks. The theoretical calculations were in basic agreement with the experimental results.

(COMPUTER MODELING, ISOTROPIC MEDIA, THERMAL CONDUCTIVITY)

HP78 31006 TEMPERATURE AND PRESSURE CHANGES IN THE VAPOR DUCT OF A HIGH-TEMPERATURE HEAT PIPE

Tolubinskiy, V.I., Shevchuk, E.N., Chistop'Yanova, N.V., (Engng. Thermophys. Inst. Acad. of Sci., Ukrainian, USSR), Heat Transfer - Sov. Res. (USA), V 7:111-115, N5, 2 refs, Sept - Oct 1975
Avail:TAC

No abstract available

(TWO-PHASE FLOW, EVAPORATOR, CONDENSER)

HP78 31007 CENTRIFUGAL COAXIAL HEAT PIPES

Vasiliev, L.L., Khrolenok, V.V., (Luikov Heat & Mass Transfer Inst, Minsk, USSR), Int Heat Pipe Conf, 2nd, Bologna, Italy, Mar 31-Apr 2, 1976, Publ by Eur Space Agency (ESA SP112), Noordwijk, Netherlands, V 1:243-302, 5 refs, 1976

This paper discusses the design efficiency, heat transfer theory, working fluids, dynamics, materials, and thermal parameters of centrifugal coaxial heat pipes.

(DESIGN, HEAT TRANSFER, WORKING FLUIDS, MATERIALS)

HP78 31008 COMPUTATION OF THERMAL RESISTANCE OF LOW-TEMPERATURE HEAT TUBES

Yudashkin, A.G., Aronchik, G.I., Lempert, E.Y., (Kuibyshev Polytech Inst, USSR), J. Eng. Phys., V 30:690-692, N6, 2 refs, June 1976
Avail:TAC

A calculation is made of the thermal resistance in low-temperature tubes with the effect of the interrelation between the evaporator and the condenser on the thermal resistance taken into account.

(MATHEMATICAL MODEL, THERMAL CONDUCTIVITY)

III. C. FLUID FLOW

HP78 32000 METHOD OF CALCULATION AND INVESTIGATION OF HIGH-TEMPERATURE HEAT PIPE CHARACTERISTICS TAKING INTO ACCOUNT THE VAPOUR FLOW COMPRESSIBILITY, FRICTION AND VELOCITY PROFILE

Brovalsky, Y.A., Bystrov, P.I., Melnikov, M.V., (Acad of Sci of USSR, Moscow, USSR), Int Heat Pipe Conference, 2nd, Bologna, Italy, Mar 31-Apr 2, 1976, Publ by Eur Space Agency (ESA SP112), Noordwijk, Netherlands, V 1:113-122, 12 refs, 1976
Avail:TAC

This paper shows that channel cross-section equations of motion can be used to calculate the characteristics of the vapor phase in a heat pipe. The hydrodynamics of vapor flow, heat pipe design relations, calculations of sonic regimes, and comparison of theoretical and experimental data are discussed.

(FLUID FLOW, LIQUID METALS, VAPOR PHASE)

HP78 32001 EXCESS LIQUID IN HEAT-PIPE VAPOR SPACES

Eninger, J.E., Edwards, D.K., (TRW Defense and Space Systems Group, Redondo Beach, CA), American Institute of Aeronautics and Astronautics, Thermophysics Conference, 12th, Albuquerque, NM, AIAA paper 77-748, 7 p., June 27-29, 1977, NAS2-8310, A77-37261
Avail:TAC

A mathematical model is developed of excess liquid in heat pipes that is used to calculate the parameters governing the axial flow of liquid in fillets and puddles that form in vapor spaces. In an acceleration field, the hydrostatic pressure variation is taken into account, which results in noncircular meniscus shapes. The two specific vapor-space geometries considered are circular and the 'dee-shape' that is formed by a slab wick in a circular tube. Also presented are theoretical and experimental results for the conditions under which liquid slugs form at the ends of the vapor spaces. These results also apply to the priming of arteries.

(MATHEMATICAL MODEL, ARTERY PRIMING, AXIAL FLOW)

HP78 32002 CONTROLLABILITY ANALYSIS FOR PASSIVELY AND ACTIVELY CONTROLLED HEAT PIPES

Lehtinen, A.M., (Rockwell International Corp., Downey, CA), American Institute of Aeronautics and Astronautics, Thermophysics Conference, 12th, Albuquerque, NM, AIAA paper 77-776, 13 p., June 27-29, 1977, A77-37281
Avail:TAC

An analytical technique was developed for steady state and pseudo-transient control analysis of variable conductance heat pipes (VCHP) and feedback controlled heat pipes (FCHP). The approach uses a modified vapor temperature profile and a simple 5-node thermal network. This approach differs from past techniques in that it accounts for gas blockage of the adiabatic section and the set point temperature is referenced to the control point node rather than the vapor node. In FCHP systems, the gas inventory is determined at a design set point temperature and held constant for analysis of varying controller set point temperatures. The pseudo-transient analysis integrates the reservoir response time equations with the steady state control equations. The most significant findings were that reservoir volume increases due to controller set point, response time, and reservoir temperature limitations; and the existence of minimum and maximum controller set point temperatures when reservoir temperature limitations exist.

(FEED-BACK CONTROL, GAS FLOW, FCHP, VCHP)

HP78 32003 HEAT EXCHANGE AND FRICTION IN A SUBSONIC VAPOR FLUX OF HIGH-TEMPERATURE HEAT PIPES

Fedorov, V.N., Sasin, V.Y., (Moscow Power Inst., USSR), J. Eng Phys, V 30:258-263, N3, Mar 3, 1976
Avail:TAC

The influence of forced vapor convection on heat transport in heat pipes is examined on the basis of the solution of the energy and motion equations. It is shown that radial heat flux due to molecular heat conduction of the vapor in the evaporator is negligible.

(FORCED CONVECTION, HEAT-TRANSFER, RADIAL HEAT-FLUX)

IV. DESIGN, DEVELOPMENT, AND FABRICATION

IV. A. GENERAL

HP78 40000 MODULAR HEAT PIPE RADIATOR

Alario, J., Canaras, T., (Grumman Aerosp Corp, Bethpage, NY), ASME Pap, 11 p., N77-ENAs-39 for Meet, July 11-14, 1977
Avail:TAC

This paper describes the design, fabrication, and test results for a space radiator panel of modular construction that uses ammonia heat pipes to achieve heat rejection rates up to 420 W/M^2 (39 W/FT^2), and also incorporates a low freezing point (propane) heat pipe to promote thawing of a frozen panel. Parametric analyses and design details are presented in addition to thermal vacuum test data in the form of steady-state performance maps (net panel heat rejection versus inlet temperature) and freeze/thaw transients.

(LIFE-SUPPORT, AMMONIA, PROPANE)

HP78 40001 GOVERNMENT FUNDING FOR HEAT PIPE RESEARCH PROMISES BENEFIT FOR DIECASTERS

Die Cast. and Met. Moulding (GB), V 8:7-8, N1, 2 refs, Jan - Feb 1977
Avail:TAC

No abstract available

(EVAPORATOR DEVELOPMENT, SERVICE LIFE)

HP78 40002 IKEPIPE - A PROGRAMME FOR THE CALCULATION OF HEAT PIPES

Hage, M., (Stuttgart University, Germany), Inst Fuer Kernenergetik, July 1976, In German
Avail:NTIS

The computing program IKEPIPE at hand calculates the maximum capacity to be transferred by a heat pipe in dependence of working temperature and tilt height or angle of inclination. These calculations can be carried out for various types of heat pipes using different heat carriers. The first version of the programme at hand only calculates the transfer capacity for saturated capillary structures.

(COMPUTER PROGRAM, SATURATED CAPILLARY STRUCTURES, FLUID FLOW)

HP78 40003 MANUAL FOR HEAT PIPE DESIGN

Hermann, E., Koch, H., Kreeb, H., Perdu, M., (Dornier Syst. Friedrichshafen, Germany), Bundesminist Forsch Technol Forschungsber Weltraumforsch W., 231 p., 22 refs, Dec 17, 1976, In German with English abstract

This handbook, which consists of materials data, a compilation of the computation procedures, and performance documents showing the effects of various parameters, has been put together as a loose-leaf collection. The materials data contains the most important temperature-dependent and temperature-independent materials parameters of ordinary heat-transfer media, some wall-material data and a compatibility matrix. The performance documents give the maximum values for different parameters and operating conditions.

(MATERIALS, COMPUTATION, PERFORMANCE, PARAMETERS)

HP78 40004 HEAT PIPE DEVICE FOR THERMOMETRIC PURPOSES BETWEEN 600°C AND 1100°C

Lanza, F., Ricolfi, T., Bassani, C., Geiger, F., (Inst di Metrol 'G Colonnetti, Torino, Italy), J. Phys E. (Sci Instrum), V 9:876-878, N10, 5 refs, Oct 1976
Avail:TAC

A furnace has been developed which embodies a heat pipe device which is operative in the temperature interval from 600°C to 1100°C. The design data of the heat pipe and the results of different tests on its effectiveness in providing large isothermal regions are reported. Major thermometric applications stemming from the test results are suggested.

(HEAT-PIPE FURNACE, DESIGN, ISOTHERMAL)

HP78 41000 BOILING LIMITED HEAT PIPES IN A MID-TEMPERATURE RANGE - 150 TO 300°C

Brown, A., (Univ. of Wales, Cardiff, Wales), ASME Pap, 7 p., N77-HT-39 for Meet., 12 refs, Aug 15-17, 1977
Avail:TAC

This paper describes measurements made of evaporator performance for heat pipes with wicks made from 2 layers of fine wire mesh, one being 100 mesh and the other 400 mesh formed into a polygon section spotwelded to the pipe at the apices of the polygon. Both Thermex and water are bused as working fluid.

(WICK PERFORMANCE, THERMEX, WATER)

HP78 41001 A STRUCTURED SURFACE FOR HIGH PERFORMANCE EVAPORATIVE HEAT TRANSFER

Saaski, E.W., Hamasaki, R.H., (Sigma Research, Inc., Richland, WA), American Institute of Aeronautics and Astronautics, Thermophysics Conference, 12th, Albuquerque, NM, AIAA paper 77-778, 9 p., June 27-29, 1977, NASA-supported research, A77-37283
Avail:TAC

An evaporative surface is described for heat pipes and other two-phase heat transfer applications that consists of a hybrid composition of v-grooves and capillary wicking. Characteristics of the surface include both a high heat transfer coefficient and high heat flux capability relative to conventional open faced screw thread surfaces. With a groove density of 12.6/CM and ammonia working fluid, heat transfer coefficients in the range of 1 to 2 W/SQ CM K have been measured, along with maximum heat flux densities in excess of 20 W/SQ CM. A peak heat transfer coefficient in excess of 2.3 W/SQ CM K at 20 W/SQ CM was measured with a 37.8/CM hybrid surface.

(EVAPORATIVE SURFACE, FILM BOILING, TWO-PHASE FLOW)

HP78 41002 TOPICS IN NITRATION

Yoshida, T., Fujiwara, K., Ando, T., (Fac. Eng., Univ., Tokyo, Japan), Senryo To Yakuhin, p. 271-281, 1976, In Japanese

No abstract available

(WICK DESIGN, COMPUTER PROGRAM)

HP78 41003 STUDIES ON CAPILLARY STRUCTURES WITH REGARD TO THEIR USE IN CRYOGENIC HEAT PIPES

Molt, W., (Stuttgart Univ, TH, Germany, F.R., Inst. Fuer Kernenergetik), July 1976, In German

In cryogenic heat pipes, special attention must be paid to the capillary structure, since the capacity of these pipes is already limited by the properties of the liquid alone, i.e. low surface tension, evaporation heat and thermal conductivity, high viscosity. For a known surface tension of the liquid, the available capillarity is determined by the used capillary structure. The exact influence of the configuration of the capillary structure, which is of special importance in low-power cryogenic heat pipes (whose efficiency is always low), has not yet been fully studied for arteries and grooves. Various kinds of arteries and grooves were tested their capillarity was measured, and formulae to calculate the capillary force were established.

(LOW-POWER HEAT-PIPES, TESTING, CAPILLARY FLOW)

IV. C. MATERIALS

HP78 42000 CORROSION STUDIES OF TUNGSTEN HEAT PIPES AT TEMPERATURES UP TO 2650°C

Geiger, F., Quataert, D., (JRC EURATOM, Ispra, Italy), Int Heat Pipe Conf, 2nd, Bologna, Italy, V 1:347-356, 13 refs, Mar 31 - Apr 2, 1976, Publ by Eur Space Agency (ESA SP112), Noordwijk, Netherlands, 1976
Avail:TAC

Heat pipe corrosion tests up to 2650°C have been made, using CVD-W as wall material and Ag, Au, Cu, Ga, Ge, In and Sn as working fluids. In most of the heat pipes a strong mass transport was observed, which is attributed both to solubility and thermochemical impurity corrosion. The material combination W/Ag turned out to be most promising. After a test of app. 6 hours at 2420°C no mass transport could be detected. However, from the observed intergranular penetration of Ag into the wall of the condensation zone, the life time of this heat pipe is estimated to be limited to about 25 hours. As the intergranular corrosion may have been enhanced by the columnar structure and the porosity of the utilized CVD-W, longer life times could possibly be obtained with W of improved quality.

(TUNGSTEN ALLOYS, MASS TRANSPORT, MATERIALS)

V. TESTING AND OPERATION

HP78 50000 INVESTIGATION OF THE 'CRISIS' OF HEAT AND MASS TRANSFER IN LOW-TEMPERATURE WICKLESS HEAT PIPES

Bezrodnyi, M.K., Alekseenko, D.V., (Kievskii Politekhnicheskii Institut, Kiev, Ukranian, USSR), Teplofizika Vysokikh Temperatur, V 15:370-376, Mar - Apr 1977, A77-37927, In Russian

In the experiments described, the maximal heat transfer capacity of closed two-phase thermosiphons was studied as a function of the geometrical parameters of the adiabatic zone, the heat supply and heat release geometry, the type of working fluid, the pressure in the inner cavity, and the content of heat transfer agent in the cavity. Water, methyl alcohol, freon-11, freon-113, and freon-12 were used as the working fluid. The test results are generalized and are used to plot the maximal (critical) heat flux density against the content of heat transfer agent and other thermosiphon parameters for each of the fluids tested.

(ADIABATIC CONDITIONS, FREON, METHYL ALCOHOLS, CRITICAL HEAT-FLUX)

HP78 50001 GRAVITATIONAL EFFECTS ON THE OPERATION OF A VARIABLE CONDUCTIVE HEAT PIPE - M.S. THESIS

Owendoff, R.S., (Naval Postgraduate School, Monterey, CA), 74 p., N77-30419
Avail:TAC

A variable conductance heat pipe, measuring 2.5 CM in diameter and 152 CM in length, was built. The heat pipe was operated in both the conventional and variable conductance modes to obtain experimental data concerning performance characteristics. The input electrical power was varied from 20 to 50 watts with the heat pipe placed in both the horizontal and vertical positions. Methanol and freon 113 were selected as the working fluids; helium and krypton were the non-condensible gases. In the variable conductance mode, liquid crystals were used to observe qualitatively the temperature gradients occurring across the vapor-gas interface. Summarized performance data for the various operating conditions and graphs of the isotherms obtained from the liquid crystal data are presented.

(GRAVITATIONAL FIELDS, HELIUM, LIQUID CRYSTALS)

HP78 50002 FABRICATION AND COMPARATIVE PERFORMANCE OF THREE VARIABLE CONDUCTANCE HEAT PIPE CONCEPTS

Peeples, M.F., Calhoun, L.D., (McDonnell Douglas Astronaut Co, St. Louis, MO), ASME Pap, 9 p., N77-ENAs-42 for Meet, July 11-14, 1977
Avail:TAC

Three variable conductance heat pipes were fabricated in order to: (a) investigate the effect of tight radius bends in the adiabatic section on heat pipe performance and (b) compare the accuracy of temperature control provided by "dry" and "wet" control-gas reservoirs during variable conductance operation. The three heat pipes were geometrically similar, each having a 90.2 CM evaporator, a 12.7 CM adiabatic section, and a 36.8 CM condenser. They were each bent on a 3.8 CM radius in the adiabatic section to form a J-shape. Tilt tests, run to estimate zero-g performance, indicated a capacity of approximately 36 to 43 W-M with Freon 21 and 99 W-M with ammonia. The corresponding analytical predictions were 42 and 140 W-M, respectively. Vacuum chamber tests indicated adequate temperature control (293 + or - 2^{O}K for a heat load turn-down ratio of 10) during cyclic condenser variations between 172 and 283^{O}K.

(TEMPERATURE CONTROL, TILT TESTS, LIFE-SUPPORT SYSTEMS)

HP78 50003 THERMAL ENERGY STORAGE DEMONSTRATION UNIT FOR VUILLEUMIER CRYOGENIC COOLER Interim Report June 2, 1975 - August 31, 1976

Richter, R., (Xerox Electro-Optical Systems, Pasadena, CA), Feb 1977

Work performed under the thermal energy storage demonstration unit program is discussed. The analysis, design, fabrication, and testing of a thermal energy storage demonstration unit which was to be mated to an existing vuilleumier cooler (AFLIR) to demonstrate the concept of powering such a device directly with stored thermal energy are presented. The thermal energy storage demonstration unit was to be sized for deliverying 1000 watts thermal power for one hour at a temperature of 1250 + or -25°F. The ternary eutectic 64 MGF_2 -30 LIF -6 KF, which has a eutectic temperature of 131°F, was selected as the thermal energy storage material. The approach and the assumptions underlying the design of the unit which incorporates a heat pipe for the transfer of energy from the thermal energy storage material to the hot cylinder of the vuilleumier cooler are presented. Details of the fabrication and the testing of the thermal energy storage demonstration unit are presented. The analysis of the test data led to the conclusion that the basic design satisfied all requirements that were established for a test unit. The thermal energy storage material, however, was found to apparently release its latent heat of fusion over a wider temperature range than had been anticipated. This fact can be attributed to nonisothermal phase transformation or a bulk thermal conductivity that is lower than had been assumed for the salt.

(TERNARY EUTECTIC, LATENT HEAT, FUSION TEMPERATURE, PHASE TRANSFORMATION)

HP78 50004 COMMERCIAL OPTIONS IN WASTE HEAT RECOVERY EQUIPMENT

Rohrer, W.M., Jr., (NBS, Washington, DC), (FEA, Washington, DC), University of Pittsburgh, Pittsburgh, PA, Feb 1977, Waste Heat Management Guidebook, Kreider, K.G., McNeil, M.B., ed., NBS-Handbook - 121

Common types of waste heat recovery equipment used in industrial plants are discussed in some detail. The operation and performance characteristics of the following types of industrial heat exchangers are described: gas-to-gas units including radiation and convection recuperators, heat wheels, heat pipe, heat exchangers, gas or liquid-to-liquid regenerators, waste heat boilers, and heat pumps.

(RECUPERATORS, RADIATION, CONVECTION, INDUSTRIAL EQUIPMENT)

HP78 50005 EXPERIMENTAL STUDY OF A HEAT-PIPE WITH AN ACTIVE POROUS SUBSTANCE

Spyridonos, A.V., (Cent. Rech. Nucl., Athens, Greece), Rev. Phys. Appl., p. 439-446, In French

No abstract available

(GYPSUM-WATER, SOLAR-HEAT-PIPE)

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E CONDUCTIVE, THESIS, GRAVIT/	GRAVITATIONAL EFFECTS, VARIABL	050001
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ERO GRAVITY, HEAT/ RE-ENTRANT	GROOVE, COMPUTERIZED DESIGN, Z	030002
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EFRIGERATOR, COOLING, MISSILE	GUIDANCE, COATING, NICKEL, SIL	023004
UDY, ACTIVE POROUS SUBSTANCE,	GYPSUM-WATER, SOLAR-HEAT-PIPE#	050005
, HEAT-PIPE, HEAT EXCHANGERS,	HEAT AND VENT ENG., OVERVIEW#	010002
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NIC VAPOR FLUX, FORCED CONVE/	HEAT EXCHANGE, FRICTION, SUBSO	032003
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E HEAT TRANSFER, CYLINDRICAL,	HEAT EXCHANGE, SOLAR ENERGY RE	022016
TE HEAT RECOVERY, / HEAT PIPE	HEAT EXCHANGER, TECHNIQUE, WAS	022014
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THERMAL CONVERSION, SOLAR-GAS	HEAT EXCHANGER# /EIVER, SOLAR-	022002
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ASTE HEAT RECOVERY, HEAT-PIPE	HEAT EXCHANGERS# /AUST-HEAT, W	022020
R EVACUATED, SOLAR COLLECTOR,	HEAT PIPE ABSORBER, CONVECTIVE	022022
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T UTILIZATION, TEMPLIFIER#	HEAT PUMP, INDUSTRY, WASTE-HEA	022000
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ONMENTS, ENERGY CONSERVATION,	HEAT RECOVERY, CORROSION RESIS	022001
LAR ENERGY, DESIGN, HEAT-PIPE	HEAT RECOVERY, ENVIRONMENTAL C	022012
PE/ COMMERCIAL OPTIONS, WASTE	HEAT RECOVERY, EQUIPMENT, RECU	050004

G, DIRTY, EXHAUST-HEAT, WASTE HEAT RECOVERY, HEAT-PIPE HEAT	022020
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T EXCHANGER, TECHNIQUE, WASTE HEAT RECOVERY, PROCESS HEAT, S	022014
DRAFT, COOLING TOWERS, WASTE HEAT RECOVERY, WASTE HEAT UTIL	022009
, CAPILLARY HEAT-PIPES, WASTE HEAT RECOVERY# /, SPINOFF 1977	022017
NG, URBAN PLANNING, HEAT-PIPE HEAT RECOVERY# /DISTRICT HEATI	022004
TOR, COOLING, MISSIL/ FUSIBLE HEAT SINK, CRYOGENIC REFRIGERA	023004
CAL MODEL, THERMAL TEST DATA, HEAT TRANSFER ELEMENTS# /ORETI	022008
AT EXCHANGE, SOLA/ CONVECTIVE HEAT TRANSFER, CYLINDRICAL, HE	022016
EAT PIPE ABSORBER, CONVECTIVE HEAT TRANSFER, ENERGY CONVERSI	022022
AL, CONFERENCE, SECOND, 1976, HEAT TRANSFER, EUR SPACE AGENC	010000
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G, SODIUM, COAXIAL HEAT-PIPE, HEAT TRANSFER# /ATICAL MODELIN	030000
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TERIZED DESIGN, ZERO GRAVITY, HEAT TRANSPORT CAPABILITYY# /U	030002
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, PIPE-LINES, DISTRICT HEATI/ HEAT TRANSPORTATION, HOT WATER	022004
S, WASTE HEAT RECOVERY, WASTE HEAT UTILIZATION# /OLING TOWER	022009
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ON, METHYL ALCOHOLS, CRITICAL HEAT-FLUX# /IC CONDITIONS, FRE	050000
ATURE, WICKLESS HEAT-PIPES, / HEAT-MASS TRANSFER, LOW-TEMPER	050000
AL MODELING, SODIUM, COAXIAL/ HEAT-MASS TRANSFER, MATHEMATIC	030000
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MY, AUTOM/ CONCEPTUAL DESIGN, HEAT-PIPE RADIATOR, FUEL ECONO	021006
TRIC, NUC/ CONCEPTUAL DESIGN, HEAT-PIPE RADIATOR, THERMOELEC	023000
ANISTER, INSTRUMENT POINTING, HEAT-PIPE RADIATOR, INSTRUMENT	023003
OLING, MATHEMATIC/ MULTISTAGE HEAT-PIPE RADIATOR, PASSIVE CO	030009
L ENGINEERING, THERMAL WHEEL, HEAT-PIPE RECUPERATOR# /OSPITA	022011
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, DIE CA/ GOVERNMENT FUNDING, HEAT-PIPE RESEARCH, DIECASTERS	010005
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ON REACTORS, REACTOR COOLING, HEAT-PIPE TEMPERATURE CONTROL#	022007
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RING THERMAL ENERGY, CHEMICAL HEAT-PIPE, CHEMICAL FEASIBILIT	021002
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ISMUTH VAPOR, LASERS, BISMUTH	HEAT-PIPE# /R, LASER ACTION, B	021004
ER, LOW-TEMPERATURE, WICKLESS	HEAT-PIPES, ADIABATIC CONDITIO	050000
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TING, SPINOFF 1977, CAPILLARY	HEAT-PIPES, WASTE HEAT RECOVER	022017
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ED THERMOSIPHONS, DE/ MAXIMUM	HEAT-TRANSFER, CLOSED TWO-PHAS	031001
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, APPLICATION, HEAT TRANSFER,	HEATING, REVIEW# /MENT, SURVEY	010001
RY HEAT-PIPES, WASTE HEAT RE/	HEATING, SPINOFF 1977, CAPILLA	022017
T WATER, PIPE-LINES, DISTRICT	HEATING, URBAN PLANNING, HEAT-	022004
T, NETWORK ARTERY HEAT-PIPES,	HEATING, VENTILATION, AIR-COND	010004
HEAT RECOVERY, PAYBACK, SPACE	HEATING, VENTILATION, INSTITUT	022006
THESIS, GRAVITATIONAL FIELDS,	HELIUM, LIQUID CRYSTALS# /VE,	050001
R, TWO-PHASE FLOW, CONDENSER,	HIGH-TEMPERATURE, EVAPORATOR#	031006
RICTION, SUBSONIC VAPOR FLUX,	HIGH-TEMPERATURE, FORCED CONVE	031003
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-AIR, THERMOELECTRIC/ VAPIPE,	HOMOGENEOUS MIXTURES, GASOLINE	021005
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T HEATI/ HEAT TRANSPORTATION,	HOT WATER, PIPE-LINES, DISTRIC	022004
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VUILLEUMIER CRYOGENIC COOLER,	INTERIM REPORT, 1975, TERNARY	050003
CND, 1976, HEAT TRANSFER, EU/	INTERNATIONAL, CONFERENCE, SEC-	010000
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-CARRYING, COMPUTER MODELING,	ISOTROPIC MEDIA, THERMAL CONDU	031005
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AL STABILITY, ERROR ANALYSIS,	LAPLACE TRANSFORM, COMPLEX THE	031000
ASERS, BISMUT/ BISMUTH LASER,	LASER ACTION, BISMUTH VAPOR, L	021004
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, THERMEX, WICK PERF/ BOILING	LIMITED, MID-TEMPERATURE RANGE	041000
GRAVITATIONAL FIELDS, HELIUM,	LIQUID CRYSTALS# /VE, THESIS,	050001
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ICAL MODELS, ARTERY P/ EXCESS	LIQUID, VAPOR SPACES, MATHEMAT	032001
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-PIPES, / HEAT-MASS TRANSFER,	LOW-TEMPERATURE, WICKLESS HEAT	050000
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E CONDUCTANCE, HEAT TRANSFER,	MASS TRANSFER, DESIGN# /ARIABL	030004
S, TUNGSTEN, TUNGSTEN ALLOYS,	MASS TRANSPORT, MATERIALS# /IE	042000
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AS, SELF-RECUPERATIVE BURNER,	METAL HEATERS# /VATION, FLUE G	022013
SSIBILITY, FLUID FLOW, LIQUID	METALS, VAPOR PHASE# /, COMPRE	032000
ICIENCY, ENERGY RECOVERY, CO/	METHANATION, THERMODYNAMIC EFF	022023
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, WICK PERF/ BOILING LIMITED,	MID-TEMPERATURE RANGE, THERMEX	041000
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D, VAPOR SPACES, MATHEMATICAL	MODELS, ARTERY PRIMING, AXIAL	032001
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LS, COMPUTATION, PERFORMANCE,	PARAMETERS# /, DESIGN, MATERIA	040003
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INES, DISTRICT HEATING, URBAN	PLANNING, HEAT-PIPE HEAT RECOV	022004
A, ELECTRON CAPTURE, CONFINED	PLASMA# /OMETER, ENERGY SPECTR	020000
AL PERFORMANCE, TESTING, FLAT	PLATE COLLECTOR, THEORETICAL M	022008
TION, PCM THERMAL CAPACITORS,	PLATFORMS, RADIATORS, SATELLIT	023001
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,/ EXPERIMENTAL STUDY, ACTIVE	POROUS SUBSTANCE, GYPSUM-WATER	050005
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